

exhibited the poor animal dead. If it had been struck by the snake, 10-15 minutes would have elapsed before death. I still seemed convinced, and on his coolly asking for the chicken for his dinner, I said I could not think of allowing him to eat a poisoned animal, and so ordered it to be buried.

Having received their bakhshee-h, both men asked me for some brandy: as, at the moment, there was none in the house, and telling them so, one pointed to a large bottle of saturated tincture of ginger which was standing in the sun, and asked what it was. On my telling him, both asked for some, so I bade them sit down, and poured a mouthful down each gullet. The unexpected pungency of the shrub astonished them, but one of them, pressing his stomach with both hands, and with his eyes streaming with tears, gasped out "aur do" (more give). The other man said he had had enough. Both then rose, and shouldering their baskets, salaamed and left the compound.

Skin shedding among Snakes.—Though I have handled exuviae by the hundred, and some of them just cast, I have never witnessed the process of skin-shedding, nor, I believe, has any observer.

It is well known that the skin is always found inverted, and very often, quite entire; and the general impression is that the snake fixes itself in a bush, or strong grass, and then wriggles out of its skin. But I have found the skin on the floor of a bath room, and on the rough ballast of a railway.

I believe that fixture is obtained by means of the abdominal scales, and that then the *modus operandi* is as follows: the skin ready to be cast, yields round the snake's mouth only, and remains adherent to the extremity of the tail. As the animal advances the caudal extremity of the skin is inverted, that is, pulled inwards, and so the process goes on, and is completed by the tail passing through the mouth of the skin; and thus the direction of the abandoned skin is directly opposite to the direction taken by the skin-casting snake. That is, if the mouth of the skin lies east, the snake went out to the west.

Take the finger of a glove, and pass a knotted thread inwards through its tip, then pull gently on it, and the tip of the glove will pass inwards and downwards, and ultimately pass through the base of the finger, which will now be uppermost.

Peshawar

H. F. HUTCHINSON

(To be continued.)

A Plague of Rats

I HAVE read with great interest in NATURE, vol. xx. p. 65, a note of Mr. Orville A. Derby's on plagues of rats in Brazil. The same thing occurs sometimes in the south of Chile, Araucania, Valdivia, and Llanquihue, when the Coligue, and other species of the Bambuseæ have flourished and fructified, an occurrence which happens every 15-25 years. These grasses, with solid canes, unbranched, of sometimes more than 10 metres long and 8 cm. thick, flourish only once in their life, when they are 15-25 years old, and then their fruits ripen in astonishing quantity. This causes an enormous multiplication of rats and mice in the woods, animals rather rare commonly; and at the end of the same or the beginning of the next year, these animals have finished with their food, and are then obliged to migrate to the cultivated district, where they are very noxious. The Indians collect the seeds of the Coligue as food, as the Brazilian natives seem to do with the fruit of the bamboo. I had occasion to observe this fact in 1869 or 1870, when I lived in Valdivia, and when almost all the Coligues of the province flourished at once and died afterwards; and I had heard it already before from the natives.

FEDERICO PHILIPPI

Santiago, Chile, August 17

Solar Halo

ON Monday, September 22, about 12 o'clock, on the coast at Burnham, Somerset, my little boy called my attention to a large, clearly-defined, white circle, of which the zenith might be the centre; on the southern side of the circumference was the sun, above which were the arcs of two other circles, one of which was flattened. They united at a small distance above the sun, and displayed rather dull prismatic colours; between the points where these arcs joined the large white circle were two rather oval-shaped patches, also showing prismatic colours. The appearance lasted about an hour and a half.

G. MAPLETON

Badgworth Rectory, Weston-super-Mare, September 23

CHEMICAL ACTION

WHY are the properties of bodies so profoundly modified by the action called chemical? Why do *certain bodies only* act chemically upon one another? What exact meaning is to be attached to the expression "chemical affinity?"

These questions, and questions such as these, have engaged the attention of chemists since chemistry began to be an exact science.

The products of chemical action are innumerable: chemical science is encumbered with a multitude of compounds, and each day additions are made to the number; but no general theory of chemical action has yet been broached which suffices to explain the known facts.

The consideration of the initial and final distribution of matter in a system upon which chemical action is exerted, has almost entirely engaged the attention of chemists, to the exclusion of the study of the course of chemical change, the conditions modifying this change, and the nature of the force which causes the change.

The molecular theory of matter furnishes us with a fairly complete answer to the question—Wherein consists the essential characteristic of chemical action?

Chemical action, says this theory, results in the production of new molecules, mechanical action results in changes in the rate of motion of existing molecules.

But why are new molecules formed only when certain bodies are brought into contact and not when other bodies are placed under similar conditions?

Because the first substances exert chemical affinity upon one another, whilst the others do not.

But what is chemical affinity?

The expression affinity was originally used to denote a resemblance between certain substances which exerted an action of some kind upon one another. But when the study of chemistry advanced, it was found that those bodies which most readily exerted mutual chemical action, were, as a rule, unlike in their chemical habitudes.

The expression affinity was, however, retained to express the fact that one body exerted chemical action upon another. This affinity could not be measured in terms of any unit, hence chemists were content to draw up tables of relative affinities. These tables were for the most part based upon qualitative reactions, and supplied merely empirical information.

In the year 1780 Bergmann formulated a general theory of chemical affinity: the main points insisted upon by Bergmann were, that the affinity between two bodies is independent of the masses of the bodies brought into mutual contact, and that the value of this affinity is constant under similar conditions. Bergmann further supposed that the relative affinity values of various substances may be empirically represented by the amounts of these bodies which mutually combine together: thus in the formation of a series of normal salts, the affinity of the acid is greatest according to Bergmann, for that base, the greatest amount of which is taken up by the acid. Conversely a base has the greatest affinity for that acid which combines with it in greatest quantity.

The latter part of Bergmann's theory could no longer be upheld when the atomic theory of Dalton had introduced clearer views concerning the quantitative action of chemical substances upon one another. But the atomic theory was not opposed to the view that the affinity between the bodies is independent of the masses of the bodies brought into mutual contact.

In the year 1803 Berthollet published his theory of chemical affinity, a theory which was essentially opposed to that of Bergmann. The French chemist said that the chemical action of one substance upon another is proportional to the mass of the acting body and to its affinity for the second substance. Berthollet thus considered not only the affinity of one body for another, but also the masses

of the acting bodies. He further took into account the physical conditions under which the chemical change proceeded, inasmuch as he regarded chemical decomposition as not completed by chemical affinity alone, but by affinity aided by cohesion and elasticity.

Upon Berthollet's view of affinity, the affinity of an acid was greatest for that base with which it combined in smallest quantity; and a substance with very small affinity for the constituents of another was nevertheless capable of decomposing that other, provided a sufficiently large mass of the first was employed.

No important general theory of chemical affinity has been propounded since the time of Berthollet; chemists have now favoured his views, now the views of Bergmann, the preponderance of opinion inclining generally towards the theory of the French chemist.

In the year 1867 a most important paper, "Etudes sur les Affinités chimiques," was published in Christiania by Professors Guldberg and Waage. This paper has been supplemented by a second communication within the last few months by the same authors: the general theory of chemical affinity has been also materially advanced by three publications made by W. Ostwald, ranging from 1877 to the present year, and entitled "Volumchemischen Studien."

These papers undoubtedly mark an epoch in the development of chemical theory, presenting, as they do, the beginnings of the application of mathematical reasoning to the facts of chemistry, and furnishing, likewise, new methods for solving some of the more intricate problems presented to the chemist.

Guldberg and Waage consider specially the influence of mass upon chemical action. In the general equation $A + B = A' + B'$, where A' and B' represent the new substances formed by the mutual actions of A and B , we have two forces at work, that causing the formation of A' and B' , and that tending to re-form A and B ; for any given stable condition of the system A, B, A', B' , these two forces are in equilibrium. The force causing the formation of A' and B' increases proportionately to the coefficient of affinity of the reaction, and is also dependent upon the quantities of A and B present. If the *active masses* of A and B (that is, the masses of these bodies present in unit volume of the reacting system) be denoted by p and q respectively, and the coefficient of affinity by k , then the force is represented by the expression kpq .

This expression may also be regarded as representing the amounts of A and B , transformed, in unit time, into A' and B' .

By a similar method the expression $k'p'q'$ is arrived at as representing the force which tends to bring about the reformation of A and B . The condition of equilibrium of the system is such that $kpq = k'p'q'$.

If p, q, p', q' be experimentally determined, the proportion $k:k'$ can be calculated, and hence the limit of the reaction for each initial condition can be determined.

Guldberg and Waage have applied their law of mass action to a number of special cases of chemical decomposition, the more important of which are decomposition of carbonates of the alkalis by barium sulphate, and the reverse action, formation of ethylic acetate and water by the action of alcohol upon acetic acid, division of a base between two acids, decomposition of hydriodic acid in presence of an excess of either iodine or hydrogen, &c.

Those actions which consist of two parts—the direct and the reverse chemical change—are especially adapted for the study of the influence of mass. This class of action is regarded by Guldberg and Waage as complete, while those in which—by the removal from the sphere of action of one of the products of the first part of the change or by other means—the reverse action is not accomplished, are regarded as incomplete. The combination of hydrogen and oxygen, for instance, to form water, is but one phase

of the complete action, the other phase of which is the decomposition of water into hydrogen and oxygen; by conducting the first part of this action at a temperature above that of the dissociation temperature of water, the action becomes complete.

In their view of chemical action, Guldberg and Waage regard the molecules of the reacting substances A and B as composed of the atoms α, γ , and β, δ respectively; these atoms are supposed to perform their own vibratory movements within the respective molecules. At certain points the force acting between α and γ and between β and δ is supposed to be very small; if, when α and γ are in this position, the molecule B come near to A , an exceedingly small disturbing influence may determine that α and β and γ and δ pair off together, to form the new molecules A' and B' . A similar view is taken of the reverse action whereby A and B are reformed.

Guldberg and Waage consider in detail only the action of mass as influencing the force of chemical affinity, but they also recognise the existence of secondary forces due to the foreign bodies present, *i.e.*, bodies which do not directly undergo chemical change during the reaction under consideration. Among these foreign bodies is to be placed the liquid in which the salts are dissolved whose mutual action is to be studied.

That the degree of dilution of the reacting liquids exerts an influence upon the course of a chemical change is witnessed to by many well known facts. Quantitative measurements of this influence are not, however, numerous.

If a molecular explanation of chemical action be adopted, we should expect to find a marked difference between the modifying influence of physical conditions upon a chemical change occurring in a dilute and the same change occurring in a more concentrated solution.

In the former case, where the molecules of the reacting bodies are comparatively widely separated from one another by those of the diluent, and where possibly a larger amount of energy of motion is associated with each molecule, one might expect that small disturbing influences would produce a marked effect upon the course of the chemical change. And such an effect is produced by small changes in physical conditions.

As one result of experiments in which I have been engaged for some time, I find that when a dilute solution of strontium chloride is mixed with a dilute solution of sulphuric acid (the molecular proportions being as 1:3 or 1:4), the amount of strontium sulphate produced in a short time—thirty to sixty minutes—is very largely dependent upon such conditions as the manner in which the two liquids are mixed, the smoothness or roughness of the vessel containing the solutions, &c., &c. Similar results have been obtained in measuring the reaction between barium chloride and potassium oxalate in dilute solutions.

But however a special chemical decomposition may be influenced by such physical conditions as those mentioned, or by such physical conditions as temperature, time, &c., it seems very probable that each chemical molecule is possessed of a definite coefficient of affinity. The researches of Guldberg and Waage, as also those of Ostwald favour this view.

The law of mass action formulated by the former naturalists does not permit of determinations being made of the coefficient of affinity of any substance, but only of the ratio between the coefficients of two substances. Ostwald also does not attempt to do more than determine the *relative affinities* of substances.

He confines himself especially to the neutralisation of acids by bases; from his results he deduces the probable conclusion that the relative affinity of an acid is a fixed number independent of the nature of the base acted upon, and independent of temperature. The relative affinity is, however, a function of the absolute affinity which is itself

probably influenced by temperature, pressure, and nature of the base neutralised. Ostwald's researches show that the affinity exerted between an acid and a base may be regarded as the product of the specific affinity-constants of the acid and of the base; *i.e.*, as made up of two parts, one of which is dependent on the acid and the other on the base.

The connection between chemical structure and affinity is touched upon by Ostwald. His numbers show that while the relative affinity of acetic acid is represented by about 1.3 (nitric acid = 100), that of monochloroacetic acid is represented by 7, that of dichloroacetic acid by 33, and that of trichloroacetic acid by 80. Similarly, the entrance of oxygen into the molecule of an acid increases the affinity, while the addition of CH_2 decreases the affinity.¹

The importance of the results, a very short sketch of which I have endeavoured to give, cannot be overlooked. We seem approaching the time when exact knowledge will be obtained of that mysterious force, chemical affinity; but before this exact knowledge is attained, much work remains to be done. Not the least of the benefits bestowed upon their fellow chemists by the three naturalists whose papers I have mentioned, is that they have directed their attention to a branch of chemical science which, although it presents great difficulties, yet promises results of the most paramount importance to science.

Cambridge, August

M. M. PATTISON MUIR

NOTES FROM ICELAND

DURING the last three weeks the writer has travelled over between four and five hundred miles of country in Iceland, in the course of which various facts have presented themselves which may interest some of the readers of this journal. These "Notes" are necessarily desultory, because the main facts connected with the natural phenomena of the country are so well known that the most we can do is to supplement some of them.

Submarine Eruption off Cape Reykjanes.—The only eruption recorded in Iceland during the present year took place off Cape Reykjanes on May 30, near the Geirfuglasker island, thirty-two miles from land. It is described by a farmer named Guðmundsson, living near Kirkjubogur, and his account of it is published in the *Heilbrigðistíndi* for June last. Smoke appeared from the sea on May 30, and on June 1 it was carried inland by a west wind. For thirteen or fourteen days it was difficult to navigate the sea about Reykjanes on account of the smoke, and just before it cleared off, ashes fell on the coast lands. An appearance as of fire was also seen out at sea. This is positively all the information we possess concerning this eruption. It is sufficiently meagre, but the district about Cape Reykjanes is very thinly populated. The road, or track, is carried over a lava-stream, and is one of the worst in Iceland; the houses are few and far between, and the keeper of the lighthouse told us we were the only visitor he had seen this year. It is probable that volcanic phenomena often pass unnoticed in a country which is so thinly peopled, that with an area one-sixth larger than that of Ireland, the population (72,000) is less than that of Norwich. Submarine eruptions have more than once previously taken place in this district; small volcanic islands have been raised above the level of the sea, and have sunk again, leaving dangerous reefs. At Cape Reykjanes (hence the name) there are numerous hot springs which deposit silica, and which are therefore of the same nature as the geysirs. The springs rise through beds of highly decomposed tuff; large quantities of steam are emitted, and the soil in the vicinity is so soft that it is necessary to carefully choose one's footing. Pools of

boiling blue mud (like the *macalube* near Girgenti) are also found in the vicinity.

Craters of the Eruption of Hekla of February, 1878.—Last autumn we gave an account in this journal (vol. xviii. p. 596) of a visit to the scene of the new eruption, which took place about four miles from the principal craters of Hekla at the end of the preceding February. The observations of Herr Nielsens, a merchant of Eyrarbakki, and of Prof. Tomas Hallgrímson, were also recorded. The former has just communicated to the writer the result of certain measurements of the principal of the new craters, which he made a few months ago. Three of the craters in the centre of the group were measured. The form of the first is that of a funnel, 100 Danish feet¹ in diameter. A good deal of steam issued from the bottom of the crater, and prevented the depth from being accurately determined, but it appears to be about 150 feet. The second crater is of horseshoe form, the straight wall joining the curve of which, is perfectly vertical. The diameter increases as it descends, being at the top about 30 feet, and at the bottom 50; while the depth is also 50 feet. The third crater is of the shape of a parallelogram, 40 feet long by 30 broad, and 40 feet deep. The walls are perpendicular. No lava issued from the second and third of these craters, but quantities of ash and pumice. The greatest quantity of lava flowed from the most southerly crater nearest to the summit of Hekla. The approach to this is very difficult on account of the extreme jaggedness of the lava. The whole field of new lava appears to be covered with an innumerable quantity of small craters, but a closer examination proves that they have been produced by the molten lava beneath forcing out portions of the upper solidified crust, at places where snow or water caused the generation of large quantities of steam. Most of the real craters are split in twain, and the sides are lined with incrustations of common salt.

A few weeks ago Miss Thora Pjetúrsson, of Reykjavík, ascended Hekla, and reports the appearance of steam from one of the main craters; last year when we ascended the mountain no trace of steam appeared from any one of the three main craters, the most recent of which was formed in 1845. Hekla only enters into eruption at long intervals of time.

Slight shocks of earthquake are common in the south-east districts, in Guldbringu Sysla and Rangarvalla Sysla.

Climate.—The presence of jokulls covered with perpetual snow; of the Gulf Stream, and of an arctic current, tend to make the climate of Iceland very variable and subject to sudden changes. On August 20, when we left Kalmanstunga, in the centre of the island, the sun was as hot as during an English mid-August day; later in the day as we passed the Geitlands jokull a piercing icy wind bore down upon us with great force, and again towards evening when we entered the northern end of the Thingvellir valley it was warm and summer-like. During the course of that day we experienced a difference of more than 100° F. Again on August 30, at Eyrarbakki, on the south coast, N. lat. 63° 65', the thermometer at 6 A.M. stood at -1° R. = 29° 75 F., and a crust of ice had formed on all exposed water. At 10 A.M. a bright hot August sun was shining and the air was still. At 3 P.M. rain and violent wind occurred, and towards evening it again cleared up. Frequently the wind drops suddenly, and a complete change of weather may take place in the course of a few hours. The summer has been unusually dry and warm, but on August 31 the weather began to break up. On that day we travelled from Eyrarbakki to Reykjavík by way of Reykir (in Ölfusahreppur), and we shall never forget the difficulties of crossing the Helliskard, a low spur of the mountain Hengill. The whole tract is either the living palagonite rock, or detached fragments heaped together in confusion. Hence it is only possible to proceed at a slow space. A violent wind

¹ The results of Ostwald, and also those of Guldberg and Waage, are corroborative of those obtained by Dr. C. R. A. Wright in a paper published in the *Phil. Mag.*, December, 1874.

¹ One Danish foot = 1.125 English foot.